



## Two new species of *Afronurus* Lestage, 1924, from Hong Kong, China (Ephemeroptera: Heptageniidae)

DIETRICH BRAASCH<sup>1</sup> & LUKE M. JACOBUS<sup>2,3</sup>

<sup>1</sup>Kantstrasse 5, D-14471 Potsdam, Germany. E-mail: d.braasch@t-online.de

<sup>2</sup>Division of Science, Indiana University Purdue University Columbus, 4601 Central Avenue, Columbus, Indiana 47203, USA.

E-mail: lukemjacobus@alumni.purdue.edu

<sup>3</sup>Corresponding author

### Abstract

*Afronurus alces*, **sp. nov.**, and *A. otus*, **sp. nov.**, are described based on male adult material from Hong Kong, China. *Afronurus alces*, **sp. nov.**, has penes that are extraordinarily differentiated and laterally expanded. *Afronurus otus*, **sp. nov.**, has a distinctive bifurcation at the tip of each penis lobe, with sharply pointed prongs that are subequal in size. Discussion is provided about the state of systematics for the tribe Afronurini Webb & McCafferty, 2007, with special reference to the genus *Afronurus* Lestage, 1924.

**Key words:** taxonomy, Asia, Africa, morphology, *Cinygmina assamensis*

The flat-headed mayfly tribe Afronurini Webb & McCafferty, 2007, (Ephemeroptera: Heptageniidae: Ecdyonurinae) currently contains the genera *Afronurus* Lestage, 1924, *Darthus* Webb & McCafferty, 2007, and *Parafronurus* Zhou & Braasch, 2003 (Webb & McCafferty, 2007). *Darthus* and *Parafronurus* each are monospecific and are known from Borneo and China, respectively (Zhou & Braasch, 2003; Webb & McCafferty, 2007). *Afronurus*, on the other hand, currently contains numerous species from Asia and Africa (Wang & McCafferty, 2004; Webb & McCafferty, 2007, 2007b). Webb & McCafferty (2008b) recently provided illustrated keys and diagnoses for identifying the male adults and larvae of Afronurini genus groups.

Wang & McCafferty (2004) considered the Asian genus *Cinygmina* Kimmins, 1937, to be a junior synonym of the more widespread Asian and African *Afronurus* because they could not identify an apomorphy to maintain *Afronurus* as a separate genus from *Cinygmina*, the latter of which has a presumably apomorphic gill morphology consisting of distinct long projections on some of the posterior gills (usually gills 5 & 6) (see, e.g., Zhou & Zheng, 2003: Fig. 8). Some other *Afronurus* species, such as *A. barnardi* Schoonbee, 1968, *A. scotti* Schoonbee, 1968, and *A. zerningi* Braasch & Freitag, 2008, also may have extensions on the gills (see, e.g., Braasch & Freitag, 2008: Fig. 51), but these extensions do not have the distinctive shape of those found in *Cinygmina*. Although they did not consider it to be a tenable genus, Wang & McCafferty (2004) considered *Cinygmina* to be an apomorphic clade within a paraphyletic *Afronurus*. Steve Jensen (unpublished), Flowers & Pescador (1984), Belfiore et al. (2003) and Kluge (2004) previously had noted the very close similarities of the two nominal genus groups, especially with respect to the morphologies of egg and larval stages.

Hereafter, we refer to the *Cinygmina* clade as the *Afronurus assamensis* group, based on the type species of *Cinygmina*. Tentatively, we include the following species (only original combinations listed) in the *assamensis* group: *Cinygmina assamensis* Kimmins, 1937; *Cinygmina cervina* Braasch & Soldán, 1984; *Afronurus chihpenensis* Kang & Yang, 1994; *Cinygmina dama* Braasch & Soldán, 1987; *Afronurus floreus* Kang & Yang, 1994; *Cinygmina furcata* Zhou & Zheng, 2003; *Cinygmina gilliesiana* Braasch, 1999; *Cinygmina hunanensis* Zhang & Cai, 1991; *Ecdyurus hyalinus* Ulmer, 1912; *Cinygmina kambakkaraiensis* Venkataraman & Sivaramakrishnan, 1989; *Cinygmina keralensis* Braasch & Soldán, 1987; *Cinygmina landai* Braasch & Soldán, 1984; *Epeorus levis* Navás, 1912 [= *Cinygmula zachvatkini* Tshernova, 1952, subj. syn. by Kluge (2004)]; *Afronurus namnaoensis* Braasch &

Boonsoong, 2010; *Afronurus nanhuensis* Kang & Yang 1994; *Cinygmina obliquistriata* You, Tian, Hong & Hsu, 1981; *Cinygmina rainulfiana* Braasch, 1999; *Cinygmina rangifera* Braasch & Soldán, 1987; *Cinygmina rubromaculata* You, Wu, Gui & Hsu, 1981; *Heptagenia viridis* Matsumura, 1933; *Cinygmina yixingensis* Wu & You, 1986; *Ecdyurus yoshidae* Takahashi, 1924 [= *Ecdyurus japonicus* Ueno, 1928, subj. syn. by Kluge (2004)].

The male adults of almost all *assamensis* group species have titillators on the penes, even if they are vestigial or very rudimentary. The notable exception is *Cinygmina*'s Asian type species, *C. assamensis* Kimmins, 1937, which apparently lacks titillators (Kimmins, 1937: Fig. 3). We examined comparative material (male adult, India, Cherrapunjee, resp. Cherrapunji, near Umhingar, 25°17' N, 91°17' E, private collection of DB, Potsdam, Germany [PCDB]) that was collected very near the type locale of *C. assamensis*, and we found that this specimen possesses very small titillators (Fig. 1) that are easily overlooked. A larva from Nepal that potentially represents *C. assamensis* was detailed by Braasch (1984: 69, Figs. 13–16, as *Cinygmina* sp.), and it has the distinctive long projections on posterior gills. We note, however, that type material of *C. assamensis* should be examined in detail for the presence or absence of titillators on the penes, and larval associations with male adults fitting the verified type concept should be confirmed. Additionally, variation in penes armature should be explored based on series of specimens, before conclusions are drawn about the *bona fide* identity of *C. assamensis* and the significance of titillators for identification or potential changes in classification.

Based on extensive material that we have examined, we note that the *assamensis* group is distributed throughout the Indian subcontinent, the subhimalayan region, China, the Russian Far East, Korea, Japan, and countries of Southeast Asia up to northern West Malaysia. Other *Afronurus* species are distributed in Africa and Southeast Asia, including Malaysia, Sundaland and the Philippines. Some species from Sundaland, the Philippines and Borneo that have shared patterns of labial palp setation, in particular, may prove to be part of another genus group in the future (J. Webb, pers. comm.).

Herein, we contribute to the systematics of *Afronurus* by describing two species from Hong Kong, China. Our male adult specimens do not correspond to any similar Asian species (Kimmins, 1937; Braasch 1990, Braasch & Soldán 1984 a, 1987, Kluge 2004, Tshernova et al. 1986, Venkataraman & Sivaramakrishnan 1989, Zhou & Cheng 2003), and thus, we consider our material to represent new species. Both belong to the *assamensis* group.

Some of this material was made available to DB by the late M. Gillies. Material examined is deposited in the Purdue University Entomological Research Collection, West Lafayette, Indiana, USA [PERC] and the private collection of the senior author, Potsdam, Germany [PCDB].

### *Afronurus alces*, sp. nov.

(Fig. 3)

**Male adult** (in ethanol). Lengths: body 8.5 mm; fore wing 9.4 mm; cerci 29 mm.

Compound eyes dark blue grey; contiguous.

Thorax yellowish. Legs yellowish; fore leg with proportions of femur : tibia : tarsus (I–V) = 128:118:76 (16:21:17:10:12).

Abdomen opaque, yellow-brown; last two segments dark brown, other segments with light brown lateral maculation and darker broad, diagonal band; posterior margins of terga narrowly dark brown; sterna immaculate. Penes extraordinarily differentiated and laterally expanded.

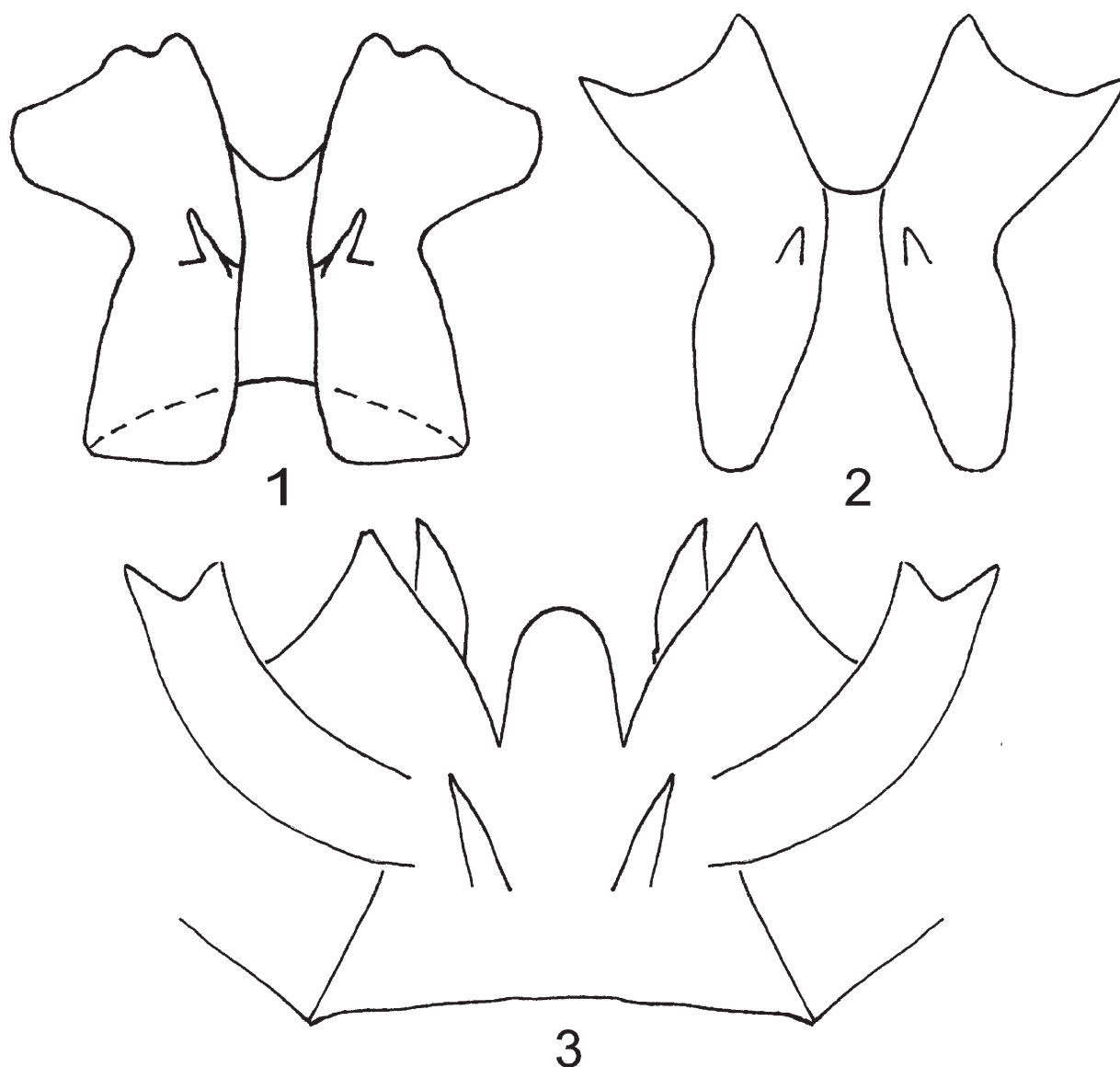
**Larva.** Unknown.

**Etymology.** The specific epithet is a noun in apposition, and it is a reference to the shape of the penes, which is suggestive of the antlers of a moose.

**Diagnosis.** *Afronurus alces* is distinguished from congeners by its very distinctive, antlerlike penes.

**Type material** (in 70% ethanol). Holotype: male adult, China, Hong Kong, New territories, Fan Ling, 20/III/1947, M. T. Gillies [PCDB]. Paratype: female adult, same data [PCDB].

**Other material examined.** Four male adults, Hong Kong, Tai Mong Tsai, 1–7/IV/1967, Philip T.P. Tsui [PERC].



FIGURES 1. *Cinygmina* cf. *assamensis* Kimmins

FIGURES 2. *Cinygmina otus*, **sp. nov.**

FIGURES 3. *Cinygmina alces*, **sp. nov.**

***Afronurus otus*, sp. nov.**

(Fig. 2)

**Male adult** (in ethanol). Lengths: body 7.2 mm; fore wing 8.2 mm; cerci broken.

Compound eyes dark violet, pale apically, with dark ring at base; contiguous.

Thorax light yellow (faded). Wings hyaline, pterostigmal region opaque. Legs light yellow, forelegs with ratios of femur : tibia : tarsi (I–V) = 115:125:159 (35:47:40:19:18); hindlegs 102:77:30 (7:5:5:3:10).

Abdomen translucent, with no apparent pattern (probably faded). Penes relatively simple, with small, acute distal projections; distinctive bifurcation at tip of each penis lobe, with sharply pointed prongs subequal in size.

**Larva.** Unknown.

**Etymology.** The specific epithet is a noun in apposition, a reference to the owl-like shape of the penes.

**Diagnosis.** *Afronurus otus*, **sp. nov.**, has a distinctive bifurcation at the tip of each penis lobe, with sharply pointed prongs that are subequal in size.

**Type material** (in 70% ethanol). Holotype: male adult, Hong Kong, Fan Ling, 16/III/1967, M.T. Gillies [PCDB].

### *Afronurus* spp.

Other samples that we have seen from Hong Kong contain Afronurini larvae that have posterior gill lamellae with elongations at their tips, as attributed to the *assamensis* group, above. Some of these larvae might correspond to one of our new species, but we cannot confidently associate them with any species at this time.

Notably, one of these larval morphotypes is highly distinctive, because it has conspicuous lateral projections on the posterior abdominal segments (e.g., Tai Nam Wo, Kowloon, 8/II/1967, P.T.P. Tsui, P., N.&M. Hsu [PERC]), such as mentioned by Webb & McCafferty (2008b). Other Hong Kong *Afronurus* larvae do not have these pronounced projections.

### Additional remarks about Afronurini systematics

Besides the identity of *Afronurus assamensis*, the heptageniid tribe Afronurini requires study in other areas, including the status of current genus groups and whether additional genus groups might exist. For example, the male adult of the monospecific *Darthus* remains undescribed.

The Vietnamese species *Afronurus meo* Nguyen & Bae, 2003, and *A. mnong* Nguyen & Bae, 2003, apparently do not have the distinct long projections of gills V and /or VI, but otherwise resemble species of the *assamensis* group.

*Afronurus separatus* (Nguyen & Bae, 2004), is another species without the distinct long gill projections of the larva, but the male adult very closely resembles the *assamensis* group in general coloration, wing and genitalia morphology. Notably, the vestigial titillators on the male penes may have been overlooked at the time of description (J. Webb, pers. comm.). However, several larval characters deviate from our concept of the *assamensis* group, including morphologies of the head, pronotum, hypopharynx, gills III and the labium. Webb et al. (2006) noted similarity between this species and *Thalerosphyrus ethiopicus* Soldán, 1977, but only *A. separatus* was transferred formally to *Afronurus* by Webb & McCafferty (2008a).

The Siberian species *Afronurus abracadabrus* Kluge, 1983, differs from all other *Afronurus* because it has a level margin of the styliger plate and lacks elevated forceps sockets; the other species have an excavated styliger plate and elevated forceps sockets. Furthermore, *A. abracadabrus* has potential autapomorphies, especially the distinctly shaped penes that lack titillators, and forceps that are sinuous in shape.

### Acknowledgments

We thank W. P. McCafferty & Arwin Provonsha (Purdue University, West Lafayette, Indiana, USA) for the loan of specimens. We thank Jeff Webb (University of Guelph, Ontario, Canada) for critical discussion and other assistance with this project. Some material examined for determining the geographic distribution of species groups is deposited in the Enns Entomological Museum, University of Missouri, Columbia, Missouri, USA; Bob Sites (Columbia, Missouri, USA) made this material available to us for study.

### References

- Belfiore, C., Barber-James, H. & Gaino, E. (2003) The eggs of *Afronurus* Lestage, 1924 (Ephemeroptera: Heptageniidae): A cue for phylogenetic relationships. Pp. 113–116, in: Gaino, E. (ed.). Research Update on Ephemeroptera & Plecoptera, University of Perugia, Perugia, Italy. 488 pp.
- Braasch, D. (1984) Beitrag zur Kenntnis der Heptageniidae des Himalaya (III) (Ephemeroptera). *Reichenbachia, Staatliches Museum Tierkunde Dresden*, 22(7), 65–74.
- Braasch, D. (1990) Neue Eintagsfliegen aus Thailand, nebst einigen Bemerkungen zu deren generischem Status (Insecta,

- Ephemeroptera: Heptageniidae). *Reichenbachia, Staatliches Museum Tierkunde Dresden*, 28(2), 7–14.
- Braasch, D. & Boonsoong, B. (2010) A contribution to the Heptageniidae (Insecta, Ephemeroptera) of Thailand and Malaysia. *Zootaxa*, 2610, 1–26.
- Braasch, D. & Freitag, H. (2008) *Palawaneuria*, a new subgenus of *Compsoeura* and new species of *Compsoeura* and *Afronurus* (Ephemeroptera, Heptageniidae) from Palawan, Philippines. *Deutsche Entomologische Zeitschrift*, 55, 117–128.
- Braasch, D. & Soldán, T. (1984) Zwei neue Arten der Gattung *Cinygmula* Kimmins, 1937 aus Vietnam (Ephemeroptera, Heptageniidae). *Reichenbachia, Staatliches Museum Tierkunde Dresden*, 22(26), 195–200.
- Braasch, D. & Soldán, T. (1987) Neue *Cinygmula*-Arten aus Vietnam (Ephemeroptera, Heptageniidae). *Reichenbachia, Staatliches Museum Tierkunde Dresden*, 24(16), 123–126.
- Flowers, R.W. & Pescador, M. (1984) A new *Afronurus* (Ephemeroptera: Heptageniidae) from the Philippines. *International Journal of Entomology*, 26(4), 362–365.
- Kimmins, D.E. (1937) Some new Ephemeroptera. *Annals and Magazine of Natural History, Series 10*, 19, 430–440 + 11 pl.
- Kluge, N. (2004) The phylogenetic system of Ephemeroptera. Kluwer Academic Publishers, Dordrecht. 442 pp.
- Tshernova, O.A., Kluge, N., Sinitshenkova, N.D. & Belov, V.V. (1986) Ephemeroptera – Podenki. Pp. 99–142 in, *Opredelitel' nasekomykh Dal'nego Vostoka SSSR*, Vol. I, Leningrad.
- Venkataraman, K. & Sivaramakrishnan, K.G. (1989) A new species of *Cinygmula* (Ephemeroptera: Heptageniidae) from South India and reevaluation of generic traits of *Cinygmula* Kimmins 1937. *Hexapoda (Insecta Indica)*, 1(1&2), 117–121.
- Wang, T.Q. & McCafferty, W.P. (2004) Heptageniidae (Ephemeroptera) of the world. Part I: Phylogenetic higher classification. *Transactions of the American Entomological Society*, 130, 11–45.
- Webb, J. & McCafferty, W.P. (2007) A new genus and species of Heptageniidae (Ephemeroptera) from Borneo, with revisions to the classification of the Ecdyonurinae. *Zootaxa*, 1478, 41–48.
- Webb, J. & McCafferty, W.P. (2008a) Adjustments to the species nomenclature of Heptageniidae (Ephemeroptera). *Proceedings of the Entomological Society of Washington*, 110, 525–527.
- Webb, J. & McCafferty, W.P. (2008b) Heptageniidae of the World. Part II: Key to the genera. *Canadian Journal of Arthropod Identification*, 7, 1–55.
- Webb, J.M., Braasch, D., & McCafferty, W.P. (2006) Reevaluation of the genera *Compsoeura* Eaton and *Trichogenia* Braasch & Soldán (Ephemeroptera: Heptageniidae). *Zootaxa*, 1335, 55–68.
- Zhou, C.F. & Zheng, L.Y. (2003) The genus *Cinygmula* (Ephemeroptera: Heptageniidae) in China, with a description of a new species. *Acta Entomologica Sinica*, 46(6), 755–760.